CLAIMS

1. A control system of an internal combustion engine provided with:

a throttle valve passage air flow calculation equation by which a throttle valve passage air flow is expressed as a function of a downstream side intake pipe pressure at the downstream side of a throttle valve and

a cylinder intake air flow calculation equation by which a cylinder intake air flow is expressed as a function of said downstream side intake pipe pressure,

said downstream side intake pipe pressure when the throttle valve passage air flow found from said throttle valve passage air flow calculation equation and the cylinder intake air flow found from said cylinder intake air flow calculation equation match being calculated as the downstream side intake pipe pressure at the time of steady operation under the operating conditions at that time.

2. A control system of an internal combustion engine provided with:

a throttle valve passage air flow calculation equation by which a throttle valve passage air flow is expressed as a function of a downstream side intake pipe pressure at the downstream side of a throttle valve and

a cylinder intake air flow calculation equation by which a cylinder intake air flow is expressed as a function of said downstream side intake pipe pressure,

said cylinder intake air flow when the throttle valve passage air flow found from said throttle valve passage air flow calculation equation and the cylinder intake air flow found from said cylinder intake air flow calculation equation match being calculated as the cylinder intake air flow at the time of steady

operation under the operating conditions at that time.

3. A control system of an internal combustion engine as set forth in claim 1, wherein said cylinder intake air flow when a throttle valve passage air flow found from said throttle valve passage air flow calculation equation and a cylinder intake air flow found from said cylinder intake air flow calculation equation match is calculated as the cylinder intake air flow at the time of steady operation under the operating conditions at that time.

4. A control system of an internal combustion engine as set forth in claim 1, wherein

said throttle valve passage air flow calculation equation is expressed as the following equation (1) where mt is a throttle valve passage air flow, μ is a flow coefficient at the throttle valve, At is a cross-sectional area of the opening of the throttle valve, Pa is an atmospheric pressure, Ta is an atmospheric temperature, R is a gas constant, Pm is said downstream side intake pipe pressure, and $\Phi(Pm/Pa)$ is a coefficient determined in accordance with the value of Pm/Pa, and

said cylinder intake air flow calculation equation is expressed as the following equation (2) where mc is a cylinder intake air flow and a and b are compliance parameters determined based on at least the engine speed:

$$mt = \mu \cdot At \cdot \frac{Pa}{\sqrt{R \cdot Ta}} \cdot \Phi\left(\frac{Pm}{Pa}\right) \qquad (1)$$

$$mc = a \cdot Pm - b \qquad (2)$$

5. A control system of an internal combustion engine as set forth in claim 2, wherein

said throttle valve passage air flow calculation equation is expressed as the following equation (1) where mt is a throttle valve passage air

flow, μ is a flow coefficient at the throttle valve, At is a cross-sectional area of the opening of the throttle valve, Pa is an atmospheric pressure, Ta is an atmospheric temperature, R is a gas constant, Pm is said downstream side intake pipe pressure, and Φ(Pm/Pa) is a coefficient determined in accordance with the value of Pm/Pa, and

said cylinder intake air flow calculation equation is expressed as the following equation (2) where mc is a cylinder intake air flow and a and b are compliance parameters determined based on at least the engine speed:

$$mt = \mu \cdot At \cdot \frac{Pa}{\sqrt{R \cdot Ta}} \cdot \Phi\left(\frac{Pm}{Pa}\right) \qquad (1)$$

$$mc = a \cdot Pm - b \qquad (2)$$

6. A control system of an internal combustion engine as set forth in claim 1, wherein said internal combustion engine has an exhaust gas recirculation passage for making at least part of the exhaust gas discharged into the exhaust passage flow into the intake passage and an EGR control valve for adjusting the flow of the exhaust gas passing through said exhaust gas recirculation passage,

said throttle valve passage air flow calculation equation is expressed as the following equation (3) wherein mt is a throttle valve passage air flow, μ is a flow coefficient at the throttle valve, At is a cross-sectional area of the opening of the throttle valve, Pa is an atmospheric pressure, Ta is an atmospheric temperature, R is a gas constant, Pm is said downstream side intake pipe pressure, and Φ(Pm/Pa) is a coefficient determined in accordance with the value of Pm/Pa, and

said cylinder intake air flow calculation

equation is expressed as the following equation (4) where mc is a cylinder intake air flow, and e and g are compliance parameters determined based on at least the engine speed and the opening degree of said EGR control valve:

$$mt = \mu \cdot At \cdot \frac{Pa}{\sqrt{R \cdot Ta}} \cdot \Phi\left(\frac{Pm}{Pa}\right) \tag{3}$$

$$mc = e \cdot Pm + g \tag{4}$$

7. A control system of an internal combustion engine as set forth in claim 2, wherein said internal combustion engine has an exhaust gas recirculation passage for making at least part of the exhaust gas discharged into the exhaust passage flow into the intake passage and an EGR control valve for adjusting the flow of the exhaust gas passing through said exhaust gas recirculation passage,

said throttle valve passage air flow calculation equation is expressed as the following equation (3) where mt is a throttle valve passage air flow, μ is a flow coefficient at the throttle valve, At is a cross-sectional area of the opening of the throttle valve, Pa is an atmospheric pressure, Ta is an atmospheric temperature, R is a gas constant, Pm is said downstream side intake pipe pressure, and Φ(Pm/Pa) is a coefficient determined in accordance with the value of Pm/Pa, and

said cylinder intake air flow calculation equation is expressed as the following equation (4) where mc is a cylinder intake air flow, and e and g are compliance parameters determined based on at least the engine speed and the opening degree of said EGR control valve:

$$mt = \mu \cdot At \cdot \frac{Pa}{\sqrt{R \cdot Ta}} \cdot \Phi\left(\frac{Pm}{Pa}\right) \tag{3}$$

$$mc = e \cdot Pm + g \qquad (4)$$

8. A control system of an internal combustion engine as set forth in claim 6, wherein said internal combustion engine further has a variable valve timing mechanism for changing an operating timing of a valve provided in each cylinder and, based on said compliance parameters e and g when said operating timing is a first valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said first valve timing and said EGR control valve is at a second opening degree, and said compliance parameters e and g when said operating timing is a second valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at said second opening degree are estimated.

9. A control system of an internal combustion engine as set forth in claim 7, wherein said internal combustion engine further has a variable valve timing mechanism for changing an operating timing of a valve provided in each cylinder and, based on said compliance parameters e and g when said operating timing is a first valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said first valve timing and said EGR control valve is at a second opening degree, and said compliance parameters e and g when said operating timing is a second valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at said second opening degree are estimated.

10. A control system of an internal combustion engine as set forth in claim 8, wherein when said compliance parameters e and g, when said operating timing

is said second valve timing and said EGR control valve is at a first opening degree, respectively, take two different values when said throttle valve downstream side intake pipe pressure is larger than and smaller than a first pressure and

said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at said second opening degree are estimated to take three or more different values in accordance with said throttle valve downstream side intake pipe pressure,

based on said compliance parameters e and g when said operating timing is a first valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said first valve timing and said EGR control valve is at a second opening degree, and said compliance parameters e and g when said operating timing is a second valve timing and said EGR control valve is at a first opening degree, approximated compliance parameters ep and gp designed to take two values differing when said throttle valve downstream side intake pipe pressure is larger and smaller than a first pressure are calculated and these are made said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at said second opening degree.

11. A control system of an internal combustion engine as set forth in claim 9, wherein when said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at a first opening degree respectively take two values different when said throttle valve downstream side intake pipe pressure is larger than and smaller than a first pressure and

said compliance parameters e and g when said operating timing is said second valve timing and

said EGR control valve is at said second opening degree are estimated to take three or more different values in accordance with said throttle valve downstream side intake pipe pressure,

based on said compliance parameters e and g when said operating timing is a first valve timing and said EGR control valve is at a first opening degree, said compliance parameters e and g when said operating timing is said first valve timing and said EGR control valve is at a second opening degree, and said compliance parameters e and g when said operating timing is a second valve timing and said EGR control valve is at a first opening degree, approximated compliance parameters ep and gp designed to take two different values when said throttle valve downstream side intake pipe pressure is larger than and smaller than a first pressure are calculated and these are made said compliance parameters e and g when said operating timing is said second valve timing and said EGR control valve is at said second opening degree.

12. A control system of an internal combustion engine as set forth in claim 8, wherein the case where said EGR control valve is at said first opening degree is the case where said EGR control valve is closed.

13. A control system of an internal combustion engine as set forth in claim 9, wherein the case where said EGR control valve is at said first opening degree is the case where said EGR control valve is closed.

14. A control system of an internal combustion engine as set forth in claim 4, wherein at a portion where the throttle valve passage air flow mt and cylinder intake air flow mc invert in magnitude, said throttle valve passage air flow calculation equation used is an approximation equation expressed by a linear equation of the downstream side intake pipe pressure Pm.

15. A control system of an internal combustion engine as set forth in claim 5, wherein at a portion

where the throttle valve passage air flow mt and cylinder intake air flow mc invert in magnitude, said throttle valve passage air flow calculation equation used is an approximation equation expressed by a linear equation of the downstream side intake pipe pressure Pm.

16. A control system of an internal combustion engine as set forth in claim 14, wherein said approximation equation is made a linear equation expressing a line connecting two points on a curve expressed by said throttle valve passage air flow calculation equation and before and after the point where the throttle valve passage air flow mt and cylinder intake air flow mc invert in magnitude.

17. A control system of an internal combustion engine as set forth in claim 15, wherein said approximation equation is made a linear equation expressing a line connecting two points on a curve expressed by said throttle valve passage air flow calculation equation and before and after the point where the throttle valve passage air flow mt and cylinder intake air flow mc invert in magnitude.

18. A control system of an internal combustion engine as set forth in claim 4, wherein instead of said atmospheric pressure Pa, a throttle valve upstream side intake pipe pressure Pac found considering at least a pressure loss of an air cleaner is used.

19. A control system of an internal combustion engine as set forth in claim 5, wherein instead of said atmospheric pressure Pa, a throttle valve upstream side intake pipe pressure Pac found considering at least a pressure loss of an air cleaner is used.

20. A control system of an internal combustion engine as set forth in claim 14, wherein

a throttle valve upstream side intake pipe pressure Pac found considering at least a pressure loss of an air cleaner is found based on the previously found throttle valve passage air flow, and

said approximation equation is made a linear equation expressing a line connecting two points shown by coordinates obtained by multiplying Pac/Pa with values of the downstream side intake pipe pressure and the throttle valve passage air flow showing coordinates of two points on a curve expressed by said throttle valve passage air flow calculation equation and before and after a point where a throttle valve passage air flow mt and cylinder intake air flow mc invert in magnitude.